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Journal of Dental Sciences (2011) 6, 235–238

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ORIGINAL ARTICLE

Effects of orthodontic treatment with fixed appliances on oral health status: A comprehensive study

Kenan Cantekin [a*], Mevlut Celikoglu [b], Muhammet Karadas [c], Hanifi Yildirim [d], Abdulvahit Erdem [d]

[a] Department of Pediatric Dentistry, Faculty of Dentistry, Ataturk University, Erzurum, Turkey
[b] Department of Orthodontics, Faculty of Dentistry, Karadeniz Technical University, Trabzon, Turkey
[c] Department of Conservative Treatment, Faculty of Dentistry, Ataturk University, Erzurum, Turkey
[d] Department of Orthodontics, Faculty of Dentistry, Ataturk University, Erzurum, Turkey

Received 5 July 2011; accepted 26 August 2011
Available online 22 October 2011

KEYWORDS
caries experience;
DMFT;
orthodontic treatment;
plaque index

Abstract *Background/purpose:* The purpose of the present study was to assess changes in the oral health status in a group of young Turkish dental patients undergoing orthodontic therapy.
Materials and methods: Data were obtained from clinical and radiographic examinations of 659 patients (with a mean age of 14.2 ± 1.59 years, including 39% males and 61% females), who were being treated with a fixed appliance in both arches at the Department of Orthodontics, Faculty of Dentistry, Ataturk University, Erzurum, Turkey. Changes in the decayed, missing, and filled permanent teeth (DMFT) counts and plaque index (PI) were evaluated. Statistical analysis was carried out using Wilcoxon and Mann–Whitney *U* tests.
Results: Total DMFT counts at the time of debonding were higher than at prebonding ($P < 0.05$) with no gender difference. The PI showed minimum values at the beginning of orthodontic therapy and maximum values at the end of therapy.
Conclusions: The results of this study showed that DMFT counts and the PI increased in a group of young dental patients undergoing orthodontic therapy, and thus patients undergoing orthodontic therapy must follow very rigid oral hygiene protocols.
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* Corresponding author. Department of Pediatric Dentistry, Faculty of Dentistry, Ataturk University, 25240 Erzurum, Turkey.
E-mail address: k_cantekin@hotmail.com (K. Cantekin).

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doi:10.1016/j.jds.2011.09.010

Introduction

Dental caries is a common chronic disease. Its prevalence varies considerably, even in developed Western countries.[1] Monitoring one's health is also important because the occurrence of dental caries and gingival problems can often result in pain and abscesses necessitating urgent dental treatment.[2] Orthodontic treatment with fixed appliances based on brackets and archwires creates numerous plaque retention sites and thus increases a patient's risk of developing caries and inflammatory reactions in gingival tissue. In addition, the majority of patients undergoing orthodontic treatment are teenagers. This may also enhance the risk of poor compliance regarding plaque control and prevention.[3]

Several reports[4,5] have documented significant increases in oral bacteria during orthodontic treatment. Some researchers believe that orthodontic therapy makes good oral hygiene more difficult, modifying the oral environment, and increasing caries activity as measured by increased salivary concentrations of lactobacilli, which are considered to be the source of the acid that demineralizes the enamel.

After removal of bands and brackets at the end of active orthodontic treatment, clinical examinations often identify the presence of lesions, which may range in severity from incipient, non-cavitated to advanced cavitated, carious lesions. Therefore, patients with fixed appliances must follow very rigid oral hygiene protocols to avoid such side effects.

However, descriptions of changes in the oral health status of dental patients undergoing orthodontic therapy are limited in the literature. The aim of the present study was, therefore, to assess changes in the oral health status and activity of oral care motivation in a group of Turkish dental patients undergoing orthodontic therapy.

Materials and methods

Ethical approval from the local ethics committee and informed consent from the parents of the children were obtained.

Data were obtained from clinical and radiographic examinations of patients being treated with a fixed appliance in both arches at the Department of Orthodontics, Faculty of Dentistry, Ataturk University, from June 2006 to January 2010. Selection criteria included aged 12—18 years, healthy, a moderate socioeconomic status, and a treatment period with fixed appliance of at least 24 months at the debonding appointment. All evaluations were carried out prior to and after orthodontic therapy by a single investigator. As exposure to X-rays by untreated orthodontic patients is not ethical, a control group of untreated orthodontic patients was not included in this study.

Clinical oral health status was measured with a mouth mirror and a blunt probe under clinical lighting, prior to and after drying the tooth surface with compressed air according to the World Health Organization caries diagnostic criteria for epidemiological studies.[6] A tooth was marked as 'decayed' when any of the following was observed: unmistakable cavitation on the occlusal, buccal, or lingual walls of the tooth; a detectable softened floor or wall, or remaining, carious roots; and a filled tooth with signs of caries. Caries occurrence was expressed as the decayed, missing (due to caries), and filled permanent teeth (DMFT) count.

The health status of the periodontal tissues was determined using periodontal indices with a modified plaque index (PI) according to Silness and Loe.[7] The PI was assessed according to plaque accumulation in the gingival area in four grades with the following scoring criteria: 0, no plaque or debris on inspection and probing; 1, a thin film of plaque only visible after probing; 2, a ribbon-like layer of plaque covering the sulcus and gingival crown areas but not filling the interdental spaces; and 3, a thick layer of plaque visible on inspection and filling the interdental spaces.

Measurements of the PI were obtained at the first appointment (T1), 1 month later for available patients (T2), and at the end of orthodontic treatment (T3).

For better comparisons, an average score was calculated for all patients and for both appointments, prior to and at the end, according to the following formula: sum of individual scores/number of gradable sites. The resulting value was considered a reflection of a patient's oral health experience.

After each examination, information concerning their oral hygiene status and how to improve it was given to the patients. At the start of the fixed appliance treatment, patients were instructed to brush their teeth with fluoride-containing toothpaste three times a day with a modified Bass method as illustrated with models for a minimum of 3 minutes each time, while also using interdental brushing and flossing. A sodium fluoride mouth rinse was also prescribed. They were also instructed on dietary habits to restrict sugary food and drink consumption. Oral hygiene was checked at the appointments every 4^{th} or 5^{th} week and, if necessary, instructions were repeated, and patients were referred to the Department of Periodontology for additional checking of oral hygiene.

Radiographic evaluation

A radiographic examination was used to evaluate the caries status from the first premolar mesial to the second molar distal by means of periapical and panoramic radiographs. Radiographic evaluation was carried out in a darkened room with a radiographic illuminator to ensure contrast enhancement of the tooth images.

Statistical analysis

The Kolmogorov—Smirnov test was used to test the normality of the distribution of DMFT counts in each gender and age group. Statistical analyses were carried out using the Wilcoxon and Mann—Whitney *U* tests. Descriptive data are also given as appropriate as calculated using SPSS version 15 (SPSS, Chicago, IL, USA). Differences were considered statistically significant at a P value < 0.05.

To assess reliability, 10% of randomly selected radiographs were re-examined 30 days after the first appointment by the same observer, and a reproducibility of 100% was obtained in identifying decay.

Results

The analyses to test the distribution of the data showed a non-normal distribution, and thus nonparametric tests were used in this study.

Data of 659 patients (with a mean age of 14.2 ± 1.59 years, including 39% males and 61% females) were available for analysis from the end of the treatment period (mean 28.51 ± 1.89 months). In Table 1, changes in DMFT counts during orthodontic treatment with a fixed appliance are presented. Total DMFT counts after debonding were higher than those at the first appointment ($P < 0.05$). Mean DMFT counts were 2.02 ± 2.31 and 2.38 ± 2.23 at the prebonding and debonding periods, respectively. Although the DMFT counts of males increased more than that of females, the difference between genders was not significant ($P > 0.05$). Table 2 shows the distribution of DMFT counts according to the age of the patient. Changes in DMFT counts at the last appointment were the highest for 12-year-old children, and the least for 18-year-old children. The majority of caries lesions were found in gingival areas, and more often affected teeth were maxillary lateral incisors and mandibular premolars and molars.

The PI was 1.08 ± 0.39 at the beginning of orthodontic therapy, with the minimal value found at T2 of 1.02 ± 0.38, and the maximal value at T3 of 1.42 ± 0.31 (Table 3).

Discussion

In this study, the most important finding was a negative effect of orthodontic treatment on the oral health status of these patients. Descriptions of the effects of orthodontic treatment on the oral status in orthodontic patient populations are limited in the literature. A few studies were carried out by clinical examinations with different methods such as fluorescence lights,[8,9] scanning electron microscopy (SEM),[10] and a cariogram study.[11]

Some authors[8,12] suggested that orthodontic treatment with a fixed appliance may be compatible with an increased incidence of caries, and thus orthodontic treatment itself has always been criticized. Some authors,[10,13,14] however, found no relationship between fixed orthodontic treatment and caries experience.

Table 1 Changes in DMFT values during orthodontic treatment with fixed appliances.

	T1 (n = 659)	T3 (n = 659)	MD	P1	P2
Female (n = 401)	1.99 ± 2.31	2.31 ± 2.56	0.32	<0.001	0.07
Male (n = 258)	2.08 ± 2.33	2.50 ± 2.19	0.42	<0.001	
Total (n = 659)	2.02 ± 2.31	2.38 ± 2.23	0.36	<0.001	

MD = mean difference; P1 = P value showing the result of Wilcoxon signed rank test; P2 = P value showing the result of Mann–Whitney U test (sex difference); T1 = fist appointment; T3 = debonding (last appointment).

Table 2 Data of DMFT prior to and after orthodontic treatment with fixed appliances for each age group.

Age (y)		DMFT		
		T1	T3	D
12 (n = 134)	M	1.74 ± 2.03	2.20 ± 1.91	0.46
	T	234	295	61
13 (n = 113)	M	1.59 ± 1.87	2.03 ± 1.77	0.44
	T	180	230	50
14 (n = 138)	M	2.36 ± 2.26	2.71 ± 2.16	0.35
	T	327	374	47
15 (n = 125)	M	1.73 ± 2.29	2.07 ± 2.25	0.34
	T	217	259	42
16 (n = 20)	M	3.30 ± 3.51	3.55 ± 3.53	0.25
	T	66	71	5
17 (n = 24)	M	3.41 ± 2.93	3.66 ± 2.79	0.25
	T	82	88	6
18 (n = 105)	M	2.20 ± 2.21	2.44 ± 2.48	0.24
	T	231	257	26
T (n = 659)	M	2.02 ± 2.31	2.38 ± 2.30	0.36
	T	1337	1574	237

D = difference; M = mean; T = total; T1 = fist appointment; T3 = debonding (last appointment).

The outcome of the present study showed that orthodontic treatment with a fixed appliance increased the risk of oral hygiene status. This finding is in agreement with the results of several studies.[5,8,15] However, Wisth and Nord[14] evaluated changes in the caries experience of 26 girls and 26 boys who had received orthodontic treatment and compared the results to a control group consisting of 58 girls and 53 boys who had not received orthodontic treatment in Norway. Surprisingly, the percentage distribution of DMFT counts indicated somewhat fewer caries in the treated group. They explained that regular hygiene control during orthodontic treatment was the reason for this situation. As a control group (who had not received orthodontic treatment) was not used in this study owing to ethical reasons, we could not compare our results with data of patients who had not received orthodontic treatment.

The change in DMFT counts during orthodontic treatment was highest for 12-year-old children, and the least for 18-year-old children. Respective values for 12-, 15-, and 18-year-old children were 0.46, 0.34, and 0.24. This might have been due to the increased consciousness of oral care with an older age group. In addition, a person's physical and mental maturity may also play a role.

In this study, another important finding was the negative effect of orthodontic treatment with a fixed appliance on

Table 3 Changes of plaque index (PI) during treatment with fixed appliances.

	Mean	SD
T1	1.08	0.39
T2	1.02	0.38
T3	1.42	0.31

SD = standard deviation; T1 = first appointment; T2 = 1 month after bracket placement; T3 = last appointment.

plaque accumulation. Assessment of the PI showed a decrease beginning from initiation of fixed therapy to the T2 control. This can be explained by the effects of oral hygiene instruction given prior to placement of the fixed appliance. However, it was limited to 1 month. The maximum value of the PI was seen at T3. This finding is in agreement with other authors,[16,17] who found a positive correlation between plaque accumulation and orthodontic treatment with a fixed appliance. The results of this study can be compared to similar studies in which clinical and microbiological effects of fixed appliances were investigated not only during fixed treatment but also after removal of the bands and brackets.[18] Contrary to our findings, in those studies, values of periodontal indices and microbiological findings began to increase after application of the fixed appliance. In most cases, values reached their maximum after 1 month followed by a decrease through the entire study.[19]

Some of the studies investigating the influence of fixed appliances on periodontal conditions showed that fixed orthodontic treatment may worsen periodontal health, which significantly improved again after debonding. Those studies also detected a greater loss of the clinical attachment level in distal parts of the dental arches.[18] This was explained by the worse oral hygiene in molar regions and by the presence of bands as larger attachments. Similar to those results, Zachrisson[20] also pointed out that more gingivitis occurred around molars.

In a recent report[21] published in Turkey, it was stated that mandibular central incisors were least likely to experience caries, whereas maxillary and mandibular molars demonstrated the highest rates of caries. Furthermore, caries teeth were more common among younger patients, and this rate decreased with age. In the present study, the majority of caries lesions were found in gingival areas and, in particular, affected teeth were maxillary lateral incisors and mandibular premolars and molars. In agreement with these authors, changes in DMFT counts in our study were highest for 12-year-old children and least for 18-year-old children.

Conclusions

The results of this study show that DMFT counts and the PI increased in a group of young dental patients undergoing orthodontic therapy, and thus patients undergoing orthodontic therapy must follow very rigid oral hygiene protocols.

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